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# METHOD FOR PROVIDING ACCESS TO AN EXTENDED COLOR GAMUT DIGITAL IMAGE AND PROVIDING PAYMENT THEREFOR


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# METHOD FOR PROVIDING ACCESS TO AN EXTENDED COLOR GAMUT DIGITAL IMAGE AND PROVIDING PAYMENT THEREFOR

## CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly assigned U.S. Patent Application

5    Serial Nos. 09/162,205 filed September 28, 1998; 09/162,026 filed September 28, 1998; 09/489,367 filed January 21, 2000; 09/162,201 filed September 16, 1998; 09/354,808 filed July 16, 1999; and _____ filed concurrently herewith entitled "Method of Professing and Paying for an Extended Color Gamut Digital Image" by Kevin E. Spaulding et al., the disclosures of which are incorporated

10   herein by reference.

## FIELD OF THE INVENTION

The present invention relates to the field of digital imaging, and more particularly to providing access to an extended color gamut digital image and providing payment therefor.

15   ## BACKGROUND OF THE INVENTION

In digital imaging systems, there are many ways to represent images in digital form. Not only are there many different formats of digital files, but there are also a large variety of different color spaces and color encodings that can be used to specify the color of digital images.

20   In some cases, the color encoding may be in terms of a so-called device independent color space, such as the well-known CIELAB color space. In recent years this color space has been used extensively to specify the color of digital images in color-managed digital imaging systems. In some cases, the image may actually be stored in the CIELAB color space. More commonly, the

25   color space may be used to connect device profiles, which can be used to describe the color characteristics of various color imaging devices such as scanners, printers, and CRT video displays. The *KODAK PhotoYCC* Color Interchange Space is another example of a device independent color space that can be used to encode digital images.

30   In other cases, the color-encoding may be in terms of a device dependent color space. Video RGB color spaces and CMYK color spaces are

examples of this type. When a color image is encoded in a device dependent color space, it will have the desired color appearance when it is displayed on the particular output device associated with that color space. The advantage of a device dependent color space is that the image is ready to be displayed or printed

5    on the target device. However, the disadvantage is that the image will necessarily be limited to the color gamut of the target device. The color gamut of an imaging device refers to the range of colors and luminance values that can be produced by the device. Therefore, if the target device has a limited dynamic range, or is incapable of reproducing certain saturated colors, then it is not possible to encode

10   color values outside of the range of colors that can be produced on the device.

One type of device dependent color space that has become quite widespread for use as a storage and manipulation color space for digital images is the video RGB color space. In reality, there are many different video RGB color spaces due to the fact that there are many different types of video RGB displays.

15   As a result, a particular set of video RGB color values will correspond to one color on one video display and to another color on another video display. Therefore, video RGB has historically been a somewhat ambiguous color representation due to the fact that the color values could not be properly interpreted unless the characteristics of the target video display were known. Nonetheless, video RGB

20   color spaces have become the defacto standard in many applications because the creation, display and editing of images on video displays are central steps in many digital imaging systems.

Recently, a particular video RGB color space known as "sRGB" has been standardized in order to remove the ambiguity in the interpretation of the

25   color values. (See "Multimedia Systems and Equipment – Colour Measurement and Management – Part 2-1: Colour Management – Default RGB Colour Space – sRGB," IEC 61966-2-1 (1999)). This color space specifies a particular set of red, green, and blue primaries, a particular whitepoint, and a particular non-linear code value to light intensity relationship. Together, these tightly define the overall

30   relationship between the digital code values and the corresponding device independent color values.

Although the use of a standard video RGB color space eliminates much of the ambiguity usually associated with video RGB color spaces, it does nothing to address the fact that this color space has a limited color gamut relative to other output devices. Additionally, any output device will have a limited color

5     gamut relative to that of an original scene. For example, a scene may have a luminance dynamic range of 1000:1 or more, whereas a typical video display or reflection print will have a dynamic range on the order of 100:1. Certain image capture devices, such as photographic negative film, can actually record dynamic ranges as large as 8000:1. Even though this is larger than the luminance dynamic

10     range associated with most scenes, the extra dynamic range is often useful to provide allowance for exposure errors, light source variations, etc.

    In order to encode images from various sources in a video RGB representation, it is necessary to discard information that is outside the color gamut of the video RGB color space. In some cases, such as when it is desired to

15     encode the appearance of colors in an original scene or the colors captured by a photographic negative, a great deal of information will typically need to be discarded due to the large disparity in the dynamic ranges. For the case where it is desired to scan a reflection print and store it in a video RGB color space, it is still necessary to discard a substantial amount of information due to the mismatch in

20     the color gamuts, even though the luminance dynamic ranges may be quite similar.

    For example, FIG. 1 shows a comparison of a typical Video RGB Color Gamut 10 and a typical Reflection Print Color Gamut 12. In this case, a*-b* cross-sections of the color gamuts are shown in the CIELAB space at an L* of 65. The colors that are inside the boundary are within the gamuts of the

25     respective devices, while those that are outside the boundary cannot be reproduced, and are therefore referred to as "out-of-gamut" colors. It can be seen that there is a large set of color values with a b* value larger than 60 that can be produced on the printer, but are outside the color gamut of the video display. As a result, if the reflection print were scanned and stored in a video RGB color space,

30     it would not be possible to encode this color information.

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The mismatch between the video RGB color gamut and the color gamuts of other output devices and image sources represents a serious limitation on the usefulness of the video RGB color space. However, in many cases, the convenience of storing the image in a color space that is ready for direct display on

5 a computer video CRT has been the over-riding factor in the determination of the preferred color space. This has come at the expense of applications that can utilize the extended color gamut information that may have existed in an input image. It has also restricted opportunities to provided additional value to the user that would be enabled by retaining the extended color gamut information.

10 **SUMMARY OF THE INVENTION**

It is an object of the present invention to overcome the limitations of the prior art by storing images in a color space having a limited color gamut, while retaining the extended color gamut information in the form of one or more residual image(s) that can be accessed when a user provides payment.

15 This object is achieved in a method for providing a user access to an extended color gamut digital image and for obtaining payment therefor, comprising the steps of: representing the extended color gamut digital image with a limited color gamut digital image and one or more associated residual image(s) representing a difference between the extended color gamut digital image and the

20 limited color gamut digital image; storing the limited color gamut digital image and the associated residual images(s) in an electronic memory; providing the user or user's designee access to the limited color gamut digital image in the electronic memory to provide a preview image; obtaining a payment identifier from the user and making payment using such payment identifier to permit the user or user's

25 designee access to the associated residual image(s); and providing the user or user's designee access to the associated residual image(s) in the electronic memory.

**ADVANTAGES**

The present invention has the advantage that a digital image can be

30 processed and presented to a user in the form of a preview image before making payment to obtain access to an extended color gamut version of the digital image.

The digital image is in a color space convenient for storage and display while overcoming the color gamut limitation associated with that color space. The image can be stored, for example, in a video RGB color space that is well-adapted for fast and convenient preview on a computer system without compromising the potential quality of the image.

The present invention has the additional advantage that a mechanism can be provided for deriving payment for the use of the extended color gamut information. Such payment can be associated with using the extended color gamut information to customize an image for a specific output device, or to perform desirable image modifications.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is graph comparing the color gamuts of a typical video display, and a typical reflection print;

FIG. 2 is a flowchart showing a process for making a limited gamut digital image in accordance with the present invention;

FIG. 3 is a flowchart showing a second process for making a limited gamut digital image in accordance with the present invention;

FIG. 4 is a flowchart showing the reconstruction of an extended gamut digital image in accordance with the present invention; and

FIG. 5 illustrates a communications network configuration.

## DETAILED DESCRIPTION OF THE INVENTION

One preferred embodiment of the present invention is shown in FIG.2. An extended color gamut digital image 20 has color values that are outside the limited color gamut of a storage color space. An adjust color values step 21 is used to limit the color values to those that will fit within the limited color gamut of the storage color space to form a limited color gamut digital image 22. Next, a represent image in storage color space step 23 is used to produce a storage space digital image 24. A compute residual image(s) step 25 is used to determine one or more residual image(s) 26 representing the difference between the extended color gamut digital image and the limited color gamut digital image. The storage space

digital image 24 and the residual image(s) 26 are then stored in a digital file 28 using a digital file storage step 27.

Each of the aspects of the invention shown in FIG. 2 will now be discussed in more detail. The extended color gamut digital image 20 can take

5   many different forms. For example, the image can be a scanned photographic print, a scanned photographic negative, a scanned photographic transparency, or an image from a digital camera, etc. Depending on the source of the image, as well as any image processing that has been applied to the image, the image may have very different color gamuts and color representations. Images from scanned

10  photographic negatives and digital cameras can contain scene information having a much larger luminance dynamic range than can be encoded in many storage color spaces. In this case, luminance dynamic range is simply one aspect of color gamut related to the range of luminance values that can be represented.

The color gamut of an imaging system is the range of colors that

15  can be represented or produced. Since color is fundamentally a three-dimensional phenomenon, color gamuts can be viewed as a three-dimensional volume. Color values that are within the volume are said to be "in-gamut," whereas colors that are outside the volume are said to be "out-of-gamut." One aspect of the color gamut is the luminance dynamic range of the system. This is the range of relative

20  luminance values that can be encoded by the system from the whitest white to the blackest black. Another aspect of the color gamut is the range of chroma values that can be represented from a neutral out to a saturated color. The extended color gamut digital image will generally have a larger luminance dynamic range and a larger range of chroma values than the limited color gamut digital image. The

25  range of chroma values that are in-gamut will generally be a function of hue and lightness. Generally, the highest chroma colors can be produced near the hue and lightness of the primary and secondary colors of a given imaging device or color space (usually red, green, blue, cyan, magenta and yellow).

If the image were a scanned photographic print, the color gamut of

30  the image would generally be the color gamut of the original photographic print medium. Likewise if the image were captured by a digital camera, the color

gamut of the image would generally be that of an original scene, although it may be limited by the dynamic range of the camera sensor and by lens flare. The color space that the image is represented in is somewhat independent of the color gamut of the original image. For example, the color values for a scanned photographic

5      print can be represented as raw scanner code values, or they can be given by device independent color values according to a color space such as the CIELAB color space. Alternatively, the color values can be expressed in some other color space.

          For many applications, it is convenient to store, display and

10     manipulate the digital image in a particular storage color space that is well-suited for the work flow associated with that application. Frequently, the storage color space that is chosen will be a device dependent color space associated with a common output device or medium used by the system. In many cases, video RGB color spaces are used because they can be displayed or previewed directly on a

15     computer video display without any further processing. Additionally, many software applications that are available to manipulate images on a computer are designed to work with images in a video RGB color space. The color gamut of the storage color space will often be smaller than, or at least different than, the color gamut of the extended color gamut digital image 20. As a result, there generally

20     will be colors in the extended color gamut digital image 20 that can not be represented in the storage color space. For example, consider the case where the extended color gamut digital image 20 is a scanned photographic print. There are many colors within the color gamut of the reflection print that are outside the color gamut of the video RGB color space. This can clearly be seen in FIG. 1 which

25     shows cross-sections through a typical Video RGB Color Gamut 10, and a typical Reflection Print Color Gamut 12.

          Therefore, information must be discarded in order to store the reflection print color values in a video RGB color space, or any other limited color gamut storage space. In prior art methods, the information that is discarded is lost

30     permanently and can not be recovered. In the present invention, the information that is lost will be stored in one or more residual image(s).

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The adjust color values step 21 is used to adjust the color values of the extended color gamut digital image to fit within the limited color gamut of the storage space, forming a limited color gamut digital image 22. In this step, information must be discarded when color values that are outside the limited color

5    gamut are mapped to color values within the limited color gamut. In some cases, the color values for the out-of-gamut colors are simply "clipped," i.e., they are mapped to color values the surface of the limited color gamut. In other cases, more sophisticated gamut mapping methods can be used to compress the extended color gamut into the limited color gamut without introducing a hard clipping

10   function. For example, the chroma of the input color values can be scaled so that the most saturated colors in the extended color gamut are mapped to the most saturated colors in the limited color gamut. Alternatively, a gamut mapping method can be used that is designed to preserve color appearance as closely as possible. Regardless of what gamut mapping technique is used, there will

15   necessarily be a loss of information and a distortion of the color characteristics of the image.

In many cases, the extended color gamut will contain color values that have higher chroma values than can be represented in the limited color gamut. In some cases, the extended color gamut may also have a larger luminance

20   dynamic range than can be represented in the limited color gamut. In the case where it is necessary to reduce the luminance dynamic range of the image, one part in the implementation of the adjust color values step 21 is typically the application of a tone scale function. The tone scale function might be applied to a luminance channel of the image, or alternatively to each color channel of an RGB

25   color representation. In some applications, the image being processed may actually be a monochrome image, e.g., a black-and-white image. In this case, the tonescale function would be applied to the image luminance values.

For cases where the extended color gamut digital image is a representation of the colors in an original scene, the adjust color values step 21

30   will typically involve determining reproduced color values that will produce desired aim colors on a target output device. For example, optimal color

reproduction aims can be applied to determine desired video RGB aim colors for the original scene colors. The process of transforming the original scene color values into aim reproduced color values is sometimes referred to as "rendering" the image.

5      Once the limited color gamut digital image 22 has been determined, the next step is to represent it in the storage color space using the represent image in storage color space step 23. The output of this step is a storage space digital image 24. This step typically involves applying a device model, or a color space conversion, to determine the storage space color values that

10     correspond to the adjusted color values of the limited color gamut digital image 22. For example, if the adjusted color values were specified in terms of the CIELAB color space, a video display device model can be used to determine the corresponding video RGB values that would be necessary to produce the specified adjusted color values.

15     A compute residual image(s) step 25 is used to determine one or more residual image(s) 26 representing the difference between the extended color gamut digital image and the limited color gamut digital image 22. In its simplest form, a residual image can be calculated by simply subtracting the adjusted color values of the limited color gamut digital image 22 from the input color values of

20     the extended color gamut digital image 20. The residual image would then be in terms of the color space used to represent those color values. Alternatively, the color values can be transformed into some other space that would be useful for computing the residual image. For example, it might be desirable to compute the residual image in a color space that is well-suited for compressing the residual

25     image or that is convenient for use in reconstructing the extended color gamut digital image. Generally, the extended color gamut digital image and the limited color gamut digital image 22 should be represented in the same color space before the residual image is calculated so that the in-gamut colors will be given by zero residual errors. Since most images will only have a small fraction of color values

30     that are out of gamut, the residual image will be dominated by zeros, and therefore will be highly compressible.

For cases where the adjust color values step 21 involves the application of a transform that modifies the color values for the colors within the limited color gamut as well as those outside the limited color gamut, a residual image determined by directly computing the difference between the input color values of the extended color gamut digital image and the adjusted color values of the limited color gamut digital image 22 would have a large number of non-zero values. This could be undesirable for cases where the residual image is to be compressed. The prior example where the extended color gamut digital image is a representation of the original scene, and the adjust color values step 21 includes rendering the color values to determine desirable color values for a target output device, will generally suffer from this problem. In this case, it can be desirable to apply a second rendering function to the extended color gamut digital image to determine a second set of rendered color values that are desirable for another output device having a larger color gamut than the first target output device. If the second rendering function were identical to the first rendering function throughout most of the color gamut, then a residual image computed by taking the difference between the first and second rendered images would again be largely dominated by zero differences. In one preferred embodiment of the present invention, the first rendering function produces a rendered image that is optimized for a video display, and the second rendering function produces a rendered image that is optimized for some hypothetical output device having an idealized large color gamut. As discussed in more detail in the co-pending U.S. Patent Application Serial No. 09/162,205 filed September 28, 1998, a set of residual images could in general be computed rather than a single residual image as has been assumed in the above discussion. The set of residual images could correspond to different spatial regions of the image, or to different subsets of the extended color gamut information, etc.

Once the residual image(s) 26 have been calculated, they should be associated in some fashion with the storage space digital image 24. This can involve storing the residual image(s) 26 in a memory buffer that is associated with a second memory buffer used to store the storage space digital image 24.

Alternatively, many applications will store the image data in a digital file 28 on some sort of digital storage media such as a magnetic disk, an optical disk, or a PCMCIA card using a digital file storage step 27. In this case, the storage space digital image 24 and the residual image(s) 26 can be stored in two different files,

5    or can be stored in the same digital image file. In many cases, the file format used to store the storage space digital image 24 may support the use of private image tags. For example, the file formats TIFF, EXIF and FlashPIX all support tags of this sort. These tags are sometimes referred to as meta-data. In cases where file formats of this type are used, it will be convenient to store the residual image(s)

10   data in the form of a residual image tag. In this way, applications that do not know how to make use of the residual image tag will simply ignore it, and will therefore have access only to the storage space digital image 24. Whereas applications that know how to use the residual image tag will be able to make use of it to reconstruct the extended color gamut digital image. Some file formats

15   place a limit on the size of tags, so compression of the residual image(s) is important for these applications.

A second preferred embodiment of the present invention is shown in FIG. 3. This embodiment is similar to that shown in FIG. 2 but differs in the way that the residual image(s) are determined. In this second embodiment, the

20   residual image(s) are represented relative to the code values of the storage color space. FIG. 3 shows an extended color gamut digital image 30, having color values that are outside the limited color gamut of a storage color space. An adjust color values step 31 is used to limit the color values to those that will fit within the limited color gamut of the storage color space. Next, a represent image in storage

25   color space step 32 is used to produce a limited color gamut digital image 33. A represent image in extended storage color space step 34 is then applied to the original image, and a compute residual image(s) step 35 is used to determine one or more residual image(s) 36 representing the difference between the extended color gamut digital image and the limited color gamut digital image, both being

30   encoded according to the storage color space. The limited color gamut digital

image 33 and the residual image(s) 36 are then stored in a digital file 38 using a digital file storage step 37.

Since most of the steps in this second embodiment of the invention are identical to the corresponding steps in the first embodiment, only the steps that differ will be discussed in more detail. The primary difference between the two embodiments is that the residual image(s) are computed relative to the storage color space color values in this case. Therefore, the original extended color space digital image must be transformed to the storage color space in addition to the limited color gamut digital image. This is accomplished by the represent image in extended storage color space step 34. The complication is that the storage color space will typically only have a limited color gamut. For example, if the storage color space is a video RGB color space, then the color gamut of the storage space would be limited to the color gamut of the video display. Therefore, to represent the original extended color gamut digital image in the storage color space, it is necessary to define an extended version of the storage color space that does not impose the limited color gamut. For example, 24-bit video RGB color spaces usually encode the color values in terms of integer code values in the range of 0 to 255. In order to allow the encoding of colors outside the color gamut of the video display, the original extended color gamut digital image can be represented in an extended storage space where the code values were allowed to go outside the range 0 to 255. This permits the encoding of colors with higher chroma values, as well as larger luminance dynamic range values, than can be encoded directly in the storage color space. After both the limited color gamut digital image and the extended color gamut digital image had been represented in terms of the storage color space, the residual image(s) 36 are then calculated as before by computing a difference between the two images.

The result of applying the method described above is the creation of both a limited color gamut digital image in a storage color space and one or more associated residual image(s) which correlates the limited color gamut digital image to an extended color gamut digital image. As discussed previously, the limited color gamut digital image is generally well suited for display on a target

output device such as a video display.  One advantage of this approach is that systems that cannot make use of the residual image(s) will be able to display and manipulate this image directly with no image quality or computation disadvantage relative to the prior art where only the limited color gamut digital image is stored.

5    However, the information that normally would have been discarded has now been stored in the residual image(s) and is available for use by systems that can utilize it.  In this case, the limited color gamut digital image is extracted and the residual image(s) from the digital file are used to form a reconstructed extended color gamut digital image.

10    Another advantage of this approach is that access to the extended color gamut digital image data can be controlled, providing an opportunity for a service provider to collect payment for such access.  FIG. 4 shows a flowchart illustrating the reconstruction of an extended color gamut digital image from the limited color gamut digital image and the residual image(s) according to the method of the

15    present invention.  The input to this process is an extended color gamut digital file 40 containing a limited color gamut digital image and one or more residual image(s) created as described above in FIG. 2 and FIG. 3.  An extract limited color gamut digital image from digital file step 41 is used to extract the limited color gamut digital image 42.  The limited color gamut digital image can be provided to

20    the user for image preview, for example on a video display.  Next, an obtain payment identifier from user step 43 is used to obtain a payment identifier from a user.  For example, the payment identifier can include information about an account from which payment is to be electronically transferred.  Alternatively, the payment identifier can include a credit card account where the payment is to be

25    debited.  Other forms of payment identifiers are also possible including information pertaining to payment by cash or check, etc.  The payment identifier can then be used to make payment 44, for example by transferring money to the account of the service provider.  An extract residual image(s) from digital file step 45 can then be used to extract the residual image(s) 46.  The residual image(s) 46

30    can them be combined with the limited color gamut digital image 42 using a

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reconstruct extended color gamut digital image step 47 to form a reconstructed
extended color gamut digital image 48.

The reconstructed extended color gamut digital image can be used
for many different purposes. For example, it can be used to form a digital image
5    appropriate for display on an output device having a color gamut different from
the limited color gamut of the limited color gamut digital image 42 in the digital
file 40. This enables the generation of an optimal print from the original extended
color gamut digital image, rather than a print limited by constraints of the storage
color space.

10    Alternatively, the information in the reconstructed extended color
gamut digital image can be used during the process of applying a modification to
the digital image. For example, consider the case where the original image is
determined to be over-exposed. In this case, the highlights of the limited color
gamut digital image would have been clipped during the adjust color values step.
15    However, the highlight information would be restored in the reconstructed
extended color gamut digital image. This information can then be used to produce
a modified digital image that retains the highlight detail. Modifications to the
digital image can be interactively specified by a user, such as in the case of a user
adjustable lightness knob. The user can also specify that modified color
20    reproduction aims should be applied to the image. For example, the user might
specify that an image with more highly saturated colors should be created.
Modifications can also be determined by applying an automatic algorithm to the
digital image. For example, a "scene balance algorithm" can be used to estimate
the best color balance and lightness level for an image.

25    FIG. 5 illustrates an embodiment of the present invention where the
extended color gamut digital images are accessed by a digital communications
network, such as the internet. In this case, an image database 50 is located on a
network server 52. The image database 50 is used to store extended color gamut
digital images 54 that have been processed using the methods described earlier to
30    form limited color gamut digital images, and associated residual image(s). The
network server 52 is connected to a communication network 55. For example, the

communication network 55 could be the internet, or a local area network. The image database 50 may contain images originating from many difference sources. For example, the image database 50 can contain images originating from scans of customer images at a retail location, or could be uploaded by the customer over

5    the digital network. A user uses a processor 56 to access the network server 52 via the communication network 55. The processor 56 can be a home computer, or alternatively it could be a computer in a retail kiosk, etc. Typically, the processor would use a monitor 58 for the purpose of displaying preview images, and providing information to the user. One or more input devices 60 can be used by

10   the user to provide instructions to the processor 56. Examples of typical input devices would include a keyboard, a mouse, a trackball, a touch pad or a touch screen. A printer 62 may also be connected to the processor for providing output prints to the user. Alternatively, a remote printer could also be accessed over the communication network 55. A card reader 64 can also be connected to the

15   processor 56 for purposes of reading account information from a credit card or a debit card.

Other network servers can also be attached to the communication network 55. For example, consider the case where a user accesses the image database 50 via the internet. After viewing a preview image, the user decides that

20   he/she wants to use the extended color gamut digital image, and is asked to provide a payment identifier. One common way for the user to provide the payment identifier to the service provider would be for him or her to enter a valid credit card number. The service provider would then access a user account database 66 on a network server 68 to debit the appropriate payment, which would

25   then be credited to an account specified by the service provider by accessing a service provider account database 70 on another network server 72. After the payment has been transferred, the service provider would then provide the user access to the residual image(s) stored in the image database 50. The residual image(s) would then typically be combined with the limited color gamut digital

30   image to form an extended color gamut digital image. The extended color gamut digital image can then be used for purposes such as creating optimal prints on a

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printer having a different color gamut than the limited color gamut digital image, or for applying desirable image modifications. For example, the user might interactively adjust the tone reproduction characteristics of the image, or might choose from a series of different color reproduction aims.

5         A computer program product having a computer readable storage medium can have a computer program stored thereon for performing all the steps of the present invention.

        A computer program product can have one or more computer readable storage media disposed in different processing locations, each having a

10    computer program stored thereon for performing all the steps of the present invention.

        Each computer readable storage medium can comprise, for example; magnetic storage media such as magnetic disc (such as a floppy disc) or magnetic tape; optical storage media such as optical disk, optical tape, or machine

15    readable bar code; solid state electronic storage devices such as random access memory (RAM), or read only memory (ROM); or any other physical device or medium employed to store a computer program.

        The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations

20    and modifications can be effected within the spirit and scope of the invention.

## PARTS LIST

| | |
|---|---|
| 10 | video RGB color gamut |
| 12 | reflection print color gamut |
| 20 | extended color gamut digital image |
| 21 | adjust color values |
| 22 | limited color gamut digital image |
| 23 | represent image in storage color space |
| 24 | storage space digital image |
| 25 | compute residual image(s) |
| 26 | residual image(s) |
| 27 | digital file storage |
| 28 | digital file |
| 30 | extended color gamut digital image |
| 31 | adjust color values |
| 32 | represent image in storage color space |
| 33 | limited color gamut digital image |
| 34 | represent image in extended storage color space |
| 35 | compute residual image(s) |
| 36 | residual image(s) |
| 37 | digital file storage |
| 38 | digital file |
| 40 | digital file |
| 41 | extract limited color gamut digital image |
| 42 | limited color gamut digital image |
| 43 | obtain payment identifier |
| 44 | make payment |
| 45 | extract residual image(s) |
| 46 | residual image(s) |
| 47 | reconstruct extended color gamut digital image |
| 48 | reconstructed extended color gamut digital image |

PARTS LIST (con't)

| 50 | image database |
| 52 | network server |
| 54 | extended color gamut digital images |
| 55 | communication network |
| 56 | processor |
| 58 | monitor |
| 60 | input device |
| 62 | printer |
| 64 | card reader |
| 66 | user account database |
| 68 | network server |
| 70 | service provider account database |
| 72 | network server |